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Epidural analgesia: effect on labor duration and delivery mode — a single-center cohort study

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ABSTRACT

Objectives: Parturients in labor experiencing severe pain may develop several complications, which could be avoided using various forms of labor analgesia. Researchers hold divergent opinions about the effect of epidural analgesia (EA) on labor duration and delivery mode. This paper aims to establish if EA affects the duration of the 1st and the 2nd phase of labor and the percentage of emergency Cesarean sections (CS) and instrumental delivery.

Material and methods: The patients in this cohort study were recruited at St. Sophia's Specialist Hospital in Warsaw, between January 1st, 2020, and June 1st, 2020 . We used following inclusion criteria: patients aged 18–40 with singleton pregnancies and cephalic presentation of the fetus who gave live birth at a gestational age of 37–42 weeks to neonates with birthweight 2500–4250 g and received EA at the cervical dilation between three and six centimeters. The control group didn't receive anesthesia. We excluded planned CS and vaginal births after CS. Data analysis was performed for all parturients and separately for multiparas and nulliparas.

Results: Out of 2550 deliveries, we included 1052 patients — 443 participants with EA and 609 in the control group. Patients with epidural analgesia experienced longer labor 415 vs 255 min ($p < 0.01$), longer 1st and 2nd stage ($p < 0.01$). They had a lower risk of emergency CS (OR = 0.56) ($p < 0.01$) but were more likely to have instrumental delivery.

Conclusions: Epidural analgesia prolongs the first and the second stage of labor yet doesn't affect neonatal outcomes. Moreover, the risk of emergency CS in nulliparas with EA is three times lower.

Keywords: cesarean section; parturition; epidural anesthesia; parity

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INTRODUCTION

Parturients describe labor pain as the worst pain they have ever endured [1]. This is because during childbirth, their body, due to pain, is exposed to hyperventilation, the release of catecholamines, and cortisol. This may cause respiratory alkalosis and uterine vasoconstriction [2], reducing oxygen transfer to the fetus and metabolic acidosis [3]. In addition, exposure to severe pain may cause mental health problems of the mother that affect relationship with the child or even with a partner [4].

To provide a comfortable birthing experience and prevent those adverse effects, healthcare professionals offer patients various forms of labor analgesia. The ideal anesthesia for childbirth should have minimal impact on the progress or outcome of labor, the fetus or newborn, and minimal maternal side effects [5]. Neuraxial analgesia meets many of these criteria [3–5] and is regarded as the gold standard [6]. However, the commonly used epidural anesthesia (EA) carries the risk of complications related to the procedure or side effects of the administered drugs [3].

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Some reports suggest that EA is associated with prolonged labor, increasing the risk of instrumental delivery and caesarean section (CS) [7–13]. However, as there is no clear standpoint on this topic, more research is needed to provide detailed and established information for the laboring parturients to facilitate their decision on labor analgesia.

Objectives

This paper aims to determine whether EA prolongs the 1st and the 2nd phase of labour and if it affects the ratio of vaginal and instrumental delivery and C-section both in nulliparas and multiparas. We hypothesize that anaesthesia prolongs the duration of labour, particularly the second phase, and increases the rate of caesarean sections and instrumental deliveries.

MATERIAL AND METHODS

Between January 1st, 2020, and June 1st, 2020, we conducted a single-center cohort study at St. Sophia's Specialists Hospital in Warsaw, obstetrics, and gynecology tertiary referral healthcare facility, to investigate the correlation between epidural analgesia and duration and mode of delivery. We followed parturients in labor and their neonates from the beginning of the 1st phase up to hospital discharge. The study has received approval from the Centre of Postgraduate Medical Education Bioethics Committee (No. 101/PB/2019). Because of retrospective analysis of anonymized data, individual patient consent was not needed. STROBE guideline for cohort studies was used to ensure proper reporting of data and outcomes [14].

Labor anesthesia and obstetric care

Our center uses EA for labor analgesia. The patients were given pain relief on demand regardless of cervical dilation. The type, volume, and concentration of administered drugs were chosen individually for each parturient by an experienced anesthesiologist. The anesthetics administered included: fentanyl (10%, 0.5%, 0.2%), lidocaine (1%), bupivacaine (0.5%, 0.1%, 1%), bupivacaine with adrenaline (0.1%, 0.5%, 0.125%, 0.625%), ropivacaine (0.2%). Detailed description of anesthetic use was presented in Supplementary Table 1. Obstetric care was similar in both groups, and a vaginal examination was performed every two hours. A specialist obstetrician made decisions concerning assisted vaginal delivery and CS according to maternal or fetal indications.

Study population

Patients were retrospectively evaluated by dividing them into groups with anesthesia (EA) and without anesthesia (no EA). Into the EA group we included only those patients, who received EA at the cervical dilatation between three to six cm. Finally, we performed an additional analysis where we stratified participants by parity (nulliparas and multiparas) within EA and no EA groups.

Data collection

Our primary outcome was the duration of labor defined as the sum of the 1st and 2nd phases and the mode of delivery (vaginal or operative childbirth). We defined the beginning of the 1st stage of labor as the mother's impression that the contractions are regular and the end as a complete cervical dilation (10 cm). The 2nd stage of labor is the time between full dilatation of the cervix and the birth of the neonate[15]. Our secondary outcomes were maternal (perineal rupture, duration of hospitalization, postpartum hemorrhage) and neonatal outcomes (Apgar score ≤ 7 points in 1st and 5th min. admission to the ICU). According to the World Health Organization (WHO) definition, postpartum hemorrhage was diagnosed as blood loss of ≥ 500 mL after vaginal delivery and ≥ 1000 mL after cesarean section [16]. We obtained individual patient data from the electronic health records and anesthesia documentation.

Study size

The number of labors in our center determined the sample size. We included all single live births at term (37––42 weeks), women aged 18–40, with the fetus in the cephalic presentation and birth weight between 2500 g and 4250 g. We excluded patients with scheduled caesarean sections and vaginal deliveries after caesarean section.

Data analysis

All statistical analyses were performed using STATISTICA 13.3 version (StatSoft Inc.). Data were demonstrated as average ± standard deviation (SD). The relationship of quantitative variables across the groups was calculated using the t-student or U Mann-Whitney test. The significance of qualitative variables was calculated using the chi-square test. Logistic regression was performed to calculate the correlation between the individual factors, and the OR (odds ratio) was calculated. For adjusted OR (aOR) calculation was performed. In all calculations, significant values were assessed for $p < 0.05$ and when 95% confidence interval (CI) did not include 1. Missing data were omitted from calculations.

RESULTS

A total of 2550 births were conducted in our centre between January 1st and June 1st. 2020. We excluded 1498 records. Out of 1052 patients included in the analysis, 443 (42.1%) participants received EA (nulliparous — 67.5%, multiparous — 32.5%) and 609 (57.9%) delivered without EA (nulliparous — 35.5%, multiparous — 64.5%). These results are shown in Figure 1. Patients in both groups had

Table 1. Demographic and clinical characteristics of parturients and their infants included in the study[a]

Characteristics	No epidural anaesthesia n = 609 [%] A ± SD	Epidural anaesthesia n = 443 [%] A ± SD	p value
Maternal age [years]	31.8 ± 4.1	30.8 ± 4.0	< 0.01
BMI before pregnancy	22.3 ± 3.9	22.8 ± 4.2	0.08
Neonatal birth weight [g]	3440.2 ± 374.2	3461.1 ± 358.2	0.36
Head circumference [cm]	34.5 ± 2.4	34.5 ± 1.5	0.82
Gestational age at delivery [weeks]	39.3 ± 1.1	39.4 ± 1.1	0.04
Parity			
Nulliparous	216 (35.5)	299 (67.5)	< 0.01
Multiparous	393 (64.5)	144 (32.5)	
Number of pregnancies			
1	184 (30.2)	258 (58.2)	
2	248 (40.7)	126 (28.5)	< 0.01
3	106 (17.4)	43 (9.7)	
> 4	71 (11.7)	16 (3.6)	
Labour induction	286 (47.0)	310 (70.0)	< 0.01
Oxytocin administration	137 (22.5)	209 (47.2)	< 0.01
Education			
Higher	338 (55.5)	224 (50.6)	
Secondary	38 (6.3)	31 (7.0)	0.55
Primary	5 (0.8)	2 (0.4)	
Missing data	228 (37.4)	186 (42.0)	
Marital Status			
Married	464 (76.2)	288 (65.0)	
Single	76 (12.5)	109 (24.6)	
Divorced	10 (1.6)	5 (1.2)	< 0.01
Widowed	0 (0.0)	1 (0.2)	
Other	3 (0.5)	1 (0.2)	
Missing data	56 (9.2)	39 (8.8)	

[a]missing data, n (%): BMI before pregnancy, 89 (9.2); head circumference, 39 (3.8); BMI — body mass index

a comparable body mass index (BMI) before pregnancy and education level. We also did not observe any significant differences in neonatal characteristics (birth weight and head circumference). In our study, more nulliparas than multiparas received EA 67.5% vs 32.5% among the EA group. Also, patients in the EA group more often had induction of labour (70% vs 47%) and administration of oxytocin (47.2% vs 22.5%) (Tab. 1). Drugs administered for EA along with doses are shown in Table S1 in the Supplementary Table.

Several factors were found to be statistically significant in the population characteristics. The induction of labour and oxytocin administration may have influenced the results, as discussed below. There were slight variations in maternal age and gestational age, but they were not clinically significant. Differences between the groups regarding marital status appear to be insignificant. From a clinical point of view, it is more important whether a patient is nulliparous or not.

Table 2 shows the comparison between EA and non-EA groups. One of the primary outcomes was the mean duration of labour which was longer in patients who received EA than those without analgesia (415 min vs 255 min). In addition, the 1st and the 2nd stages of labour were also prolonged in the EA group. In the EA group, parturients were twice more likely to give birth naturally than by caesarean section. However, they were more likely to have instrumental delivery with vacuum extraction, and their hospital stay was longer. The number of clinically significant 3rd-degree perineal lacerations did not differ between the groups. There was no association between EA and blood loss, postpartum haemorrhage, and admission to the Neonatal Intensive Care Unit. There were also no differences in Apgar scores ≤ 7 between the two groups.

The analysis shows statistically significant differences between nulliparas and multiparas with and without EA (Tab. 3). The duration of the first and second stages of labour was longer in the group with EA in nulliparas and multiparas (Fig. 2). Nulliparas who received EA were almost three times less likely to deliver by caesarean section than those without EA ($p < 0.01$). In the group of multiparas, there were no significant differences in the rate of emergency caesarean sections, but the patients with EA were more likely to give birth naturally ($p = 0.22$). In the group of nulliparas, EA did not increase the risk of longer hospitalization. However,

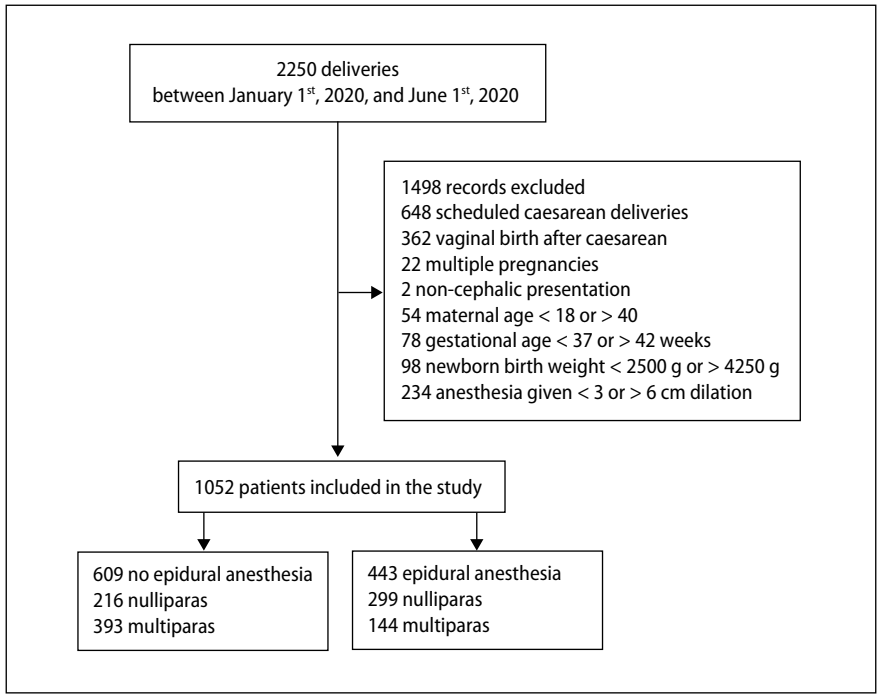

Figure 1. Study flow chart

Table 2. Outcomes correlated with epidural anaesthesia (all patients)[a]

Outcomes	No epidural anaesthesia n = 609 [%] A ± SD	Epidural anaesthesia n = 443 [%] A ± SD	p value	OR (95% CI)
Duration of labour [min]	255 ± 129	415 ± 170	< 0.01	1.006 (1.005–1.006)
Duration of 1st stage [min]	235 ± 121	379 ± 152	< 0.01	1.008 (1.007–1.010)
Duration of 2nd stage [min]	21 ± 19	35 ± 31	< 0.01	1.032 (1.024 to 1.039)
Caesarean section	107 (17.6)	47 (11)	< 0.01	0.56 (0.39–0.80)
Instrumental delivery Vacuum Forceps	15 (2.5) 15 (2.5) 0 (0.0)	24 (5.4) 22 (5.0) 2 (0.5)	0.02 0.02 1.00	2.27 (1.18–4.38) 2.07 (1.0–4.04) –
Postpartum haemorrhage	137 (22.5)	102 (23.02)	0.84	1.03 (0.77–1.38)
Blood loss [mL]	410 ± 188	417 ± 126	0.54	1.000 (0.999 to 1.001)
3rd degree perineal laceration	1 (0.2)	1 (0.2)	0.82	1.38 (0.09–22.05)
Apgar score < 7 at 1st min at 5th min	 5 (0.8) 1 (0.2)	 4 (0.9) 0 (0.0)	 0.88 1.00	 1.10 (0.29–4.12) –
Admission to neonatal intensive care unit	39 (6.4)	25 (5.6)	0.61	0.87 (0.52–1.47)
Mother's postnatal hospital stay [days]	3.76 ± 2.11	4.33 ± 2.09	< 0.01	1.14 (1.07–1.21)

[a]missing data, n (%): duration of labour, 1 (0.2); duration of 1st stage, 156 (14.8); duration of 2nd stage, 161 (15.3); blood loss, 13 (1.2); Apgar score at 1st min, 1 (0.2); Apgar score at 5th min, 2 (0.4)

in the group of multiparas, those who received EA were at a higher risk of longer hospitalization than parturients without EA. The groups did not differ significantly in the rate of instrumental deliveries, blood loss and perineal injury, Apgar score < 7, and admission to the neonatal intensive care unit. Nulliparas in the EA group were at a lower risk of postpartum haemorrhage.

DISCUSSION

This cohort study involving 1052 patients aimed to determine the effect of epidural analgesia on labor duration and delivery mode. The study showed that EA independently of the group prolongs the 1st and 2nd phase of labor. Furthermore, in the group with anesthesia, we observed a lower number of caesarean sections, higher incidence of

Table 3. Outcomes correlated with epidural anaesthesia after stratification according to parity

Outcomes	Nulliparas[a]			Multiparas[b]		
	No epidural anaesthesia N = 216 [%] A ± SD	Epidural anaesthesia N = 299 [%] A ± SD	p value	No epidural anaesthesia n = 393 [%] A ± SD	Epidural anaesthesia n = 144 [%] A ± SD	p value
Duration of labour [min]	346 ± 153	471 ± 175	< 0.01	219 ± 102	323 ± 146	< 0.01
Duration of 1st stage [min]	310 ± 145	429 ± 169	< 0.01	206 ± 100	294 ± 101	< 0.01
Duration of 2nd stage [min]	36 ± 22	43 ± 34	< 0.01	14.8 ± 12	19.6 ± 12	< 0.01
Caesarean section	66 (30.6)	39 (13.0)	< 0.01	41 (10.4)	8 (5.6)	0.22
Instrumental delivery Vacuum Forceps	 11 (5.1) 0 (0.0)	 20 (6.7) 2 (0.7)	 0.55 1.00	 4 (1.0) 0	 2 (1.4) 0	 0.77 1.00
Postpartum haemorrhage	81 (37.5)	86 (28.8)	0.04	56 (14.2)	16 (11.1)	0.43
Blood loss [mL]	451 ± 278	430 ± 131	0.60	389 ± 103	390 ± 108	0.86
3rd degree perineal laceration	0 (0.0)	0 (0.0)	1.0	1 (0.3)	1 (0.7)	0.49
Apgar score < 7 at 1st min at 5th min	 1 (0.5) 0 (0.0)	 2 (0.7) 0 (0.0)	 0.76 1.00	 4 (1.0) 1 (0.3)	 2 (1.4) 0 (0.0)	 0.73 0.54
Admission to neonatal intensive care unit	19 (8.8)	15 (5.0)	0.09	16 (5.1)	10 (6.9)	0.43
Mother's postnatal hospital stay [days]	4.25 ± 2.2	4.53 ± 2.1	0.16	3.49 ± 2.0	3.9 ± 2.0	0.02

[a]missing data, n (%): duration of labour, 1 (0.2); duration of 1st stage, 104 (20.2); duration of 2nd stage, 104 (20.2); blood loss, 7 (1.4); Apgar score at 5th min, 1 (0.2); [b]missing data, n (%): duration of 1st stage, 52 (9.7); duration of 2nd stage, 57 (10.6); blood loss, 6 (1.1); Apgar score at 1st min, 1 (0.2); Apgar score at 5th min, 1 (0.2)

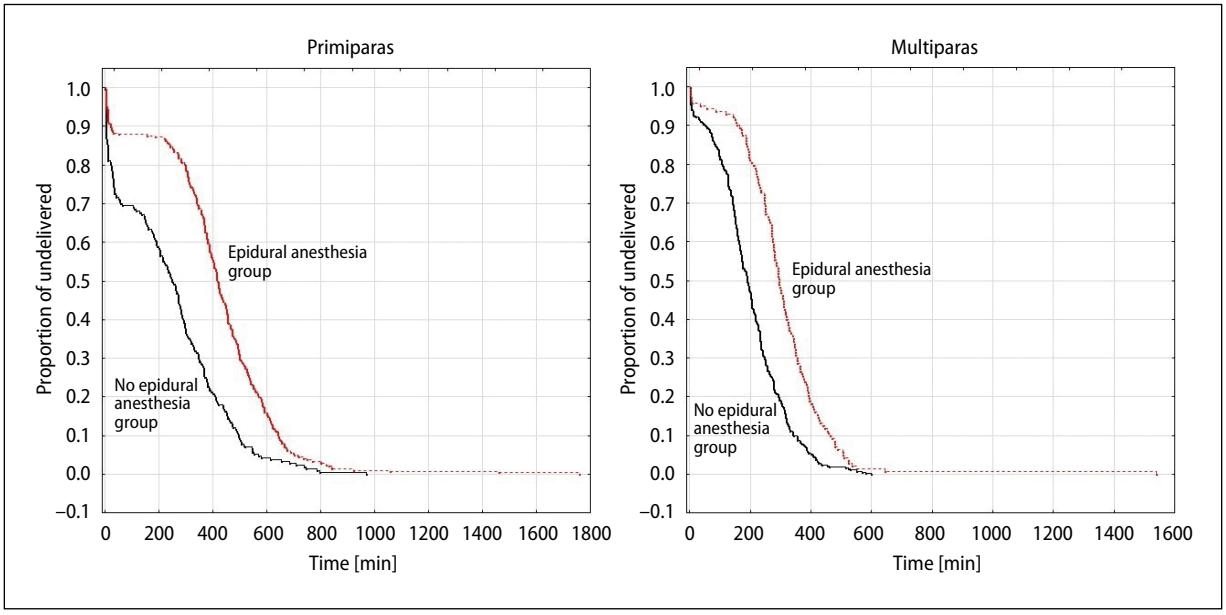

Figure 2. Kaplan–Meier survival analysis of labor duration

instrumental deliveries (vacuum), prolonged labor duration, and maternal hospitalization. In nullipara, EA remarkably lowered the number of emergency caesarean sections and was associated with a lower risk of postpartum hemorrhage. Thus, our hypothesis was confirmed in the aspect of labor duration, but the hypothesis that EA increases the rate of caesarean sections was proven false.

To date, many papers have reviewed the association between EA and the mode of delivery. In our study, EA resulted in a two-fold reduction in risk of CS in the general population and a threefold reduction/decrease in the nulliparous group. The effect of EA on the risk of CS has been reported in the literature. A study of 1733 low-risk nulliparas showed up to four times higher rates of

caesarean sections in the group of parturients who received anaesthesia [7]. In another study, the caesarean section rate was 9.2% vs 4% in the group with and without EA, respectively, but the p value was 0.06 [9]. Another randomized cohort study showed that the effect of anesthesia depends on the concentration of analgesic drugs used [17]. In our study, the analgesics and their concentrations were, heterogeneous and differed from those used in the study quoted above, they were selected by specialized anesthetists to allow patients to walk around the delivery room. This could potentially be one explanation for the differences in the results obtained.

On the other hand, no association between anaesthesia and caesarean section was demonstrated in a 2018 systematic review based on 33 randomized cohort studies (moderate-quality evidence) [8]. In the 2018 study of 207,525 births, a significantly lower rate of caesarean sections was observed in seven groups. These included multiparas labor induction, while the rate of caesarean sections was slightly higher in those with spontaneous onset of labor. So, induction of labor seems to be associated with a higher rate of caesarean section. In our study, more patients in the EA group had labor induction (70% vs 47%). Another study on the effect of EA on labor induction showed more caesarean sections among participants with anesthesia (26% vs 10.1%) [18]. However, there were more frequent post-term pregnancies in this population and significantly higher birth weight in the group with EA compared to the group without EA, which may have influenced the results. Nevertheless, other factors besides EA may likely influence the rate of emergency caesarean sections, and further research on this topic is needed.

For instrumental deliveries, we observed a twofold increase in the rate of vacuum deliveries in the group that received anesthesia. However, a separate analysis of a group of nulliparas and multiparas did not confirm this. The literature concerning the effect of EA on the rate of instrumental deliveries is more consistent. There is an abundance of papers reporting increased rates of instrumental deliveries in the group with EA [8, 10]. On the other hand, a systematic review and meta-analysis of randomized controlled trials found no association between EA (with low analgesic concentrations) and instrumental delivery. However, this meta-analysis was based on small studies of low quality [19].

In our study, the longer duration of the first and second phases of labor shown in the nulliparous and multiparas in the EA group is statistically significant. These differences showed no correlation with any serious maternal or neonatal adverse effects and can therefore be considered clinically irrelevant. The literature on the impact of EA on length of labor is inconsistent. A correlation between EA and longer duration of the 1st and the 2nd phase of labor was observed in a study involving 645 parturients in labor [9]. Other studies have also shown longer duration of labor in the group with EA [11–13]. However, the meta-analysis provides evidence that EA may even shorten the second phase of labor, depending on the combination of drugs used [20]. According to recent studies, the use of oxytocin may be associated with longer labor, which might have influenced the results of the study [21].

In our study, patients who received EA had a longer hospital stay. However, this effect was statistically significant only for multiparas, and the difference was less than half a day. In the study of Liu et. al. [22] any adverse outcomes of child and mother were found significant. The longer hospital stay was also observed in a study of Yin and Hu [23], and was probably related to increased rate of maternal intrapartum fever.

The study showed that the incidence of hemorrhage was lower in nulliparas with EA. At the same time, there was no difference in the amount of blood loss among nulliparas in the group with and without EA. We did not find similar results in the available literature. After correction, this result was not found to be statistically significant. Some studies indicate that the duration of labor affects the incidence of maternal hemorrhage [24]. However, others do not confirm an increased incidence of hemorrhage with anesthesia. Due to the discrepancy in results, further studies on this topic are needed.

In the present study, EA did not affect neonatal outcomes — neither Apgar scores at 1st and 5th minute nor the rate of ICU admissions, which is consistent with the available literature [2, 8, 24].

A key strength of this study is its applicability which is determined by a few factors. The setting of this study included a tertiary care hospital, a broad choice of analgesics dependent on anesthesiologist's discretion as in many other facilities worldwide. A large group of patients was included in the study and their range is wide — both nulliparas and multiparas. We included young adolescents as well as more mature patients.

This study has several limitations. These are primarily related to the observational retrospective character of the study as there may be other factors affecting the outcome which are not included, such as maternal position during the first [25] or second stage of labor [26]. We did not rule out any BMI category nor participants with labor induction as this is a procedure often performed in parturients. Finally, patients were given different combinations of drugs and at different concentrations, which represents the situation daily at different hospitals in Poland and worldwide.

Moreover, we could not obtain data on the participants' reasons for their decision on labor anesthesia. For example, parturients with initially longer deliveries could request for administration of anesthesia more often because of longer-lasting pain. Moreover, assessment of the onset of the 1st phase of labor is potentially subject to recall bias among the patients who initiated labor out of the hospital. In these

cases, the onset of regular contractions was subjectively estimated. Also, missing data could have affected the results.

CONCLUSIONS

Even though EA prolongs the delivery time, it is clinically irrelevant as it does not affect maternal or neonatal outcomes, whereas it provides comfort. Our study shows that EA may play a protective role and reduce the number of Cesarean sections in a particular group of patients. Statistical analysis suggests that confounders can affect the mode of delivery. Further research is therefore needed to evaluate these factors and provide parturients pain-free labor that is safe for them and their infants.

Article information and declarations

Ethics statement

The study has received approval from the Centre of Postgraduate Medical Education Bioethics Committee (No. 101/PB/2019).

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Conflict of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary material

Supplementary Table S1. Combination of drugs used to EA with doses.

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SUPPLEMENTARY MATERIAL

Supplementary Table S1. Combination of drugs used to EA with doses

Drugs combination	Patients n = 443 [%]	Fentanyl (F) A ± SD [mcg]	Lidocaine (L) A ± SD [mg]	Bupivacaine (B) A ± SD [mg]	Bupivacaine with adrenaline (BA) A ± SD [mg]	Ropivacaine (R) A ± SD [mg]
F + BA	107 (24.2)	142.1 ± 88.0	–	–	9.3 ± 4.2	–
F + L + BA	94 (21.1)	113.6 ± 95.8	32.5 ± 14.7	–	10.6 ± 4.03	–
F + R	81 (18.3)	145.1 ± 86.4	–	–	–	21.9 ± 7.0
F + L + R	58 (13.1)	131.6 ± 96.8	45.0 ± 30.8	–	–	21.5 ± 7.3
F + L + B	48 (10.8)	184.0 ± 63.3	31.7 ± 12.8	15.5 ± 12.6	–	–
F + B	45 (10.2)	52.4 ± 86.9	–	16.7 ± 7.2	–	–
Other combination	6 (1.4)	152.5 ± 82.3	35.0 ± 11.2	37.5 ± 27.5	12.0 ± 0.0	24.8 ± 7.8

*missing data, n (%): drugs combination, 4 (0.9); F 16 (3.6); L, 7 (1.6); B, 4 (0.9); BA, 16 (3.6); R, 7 (1.6)